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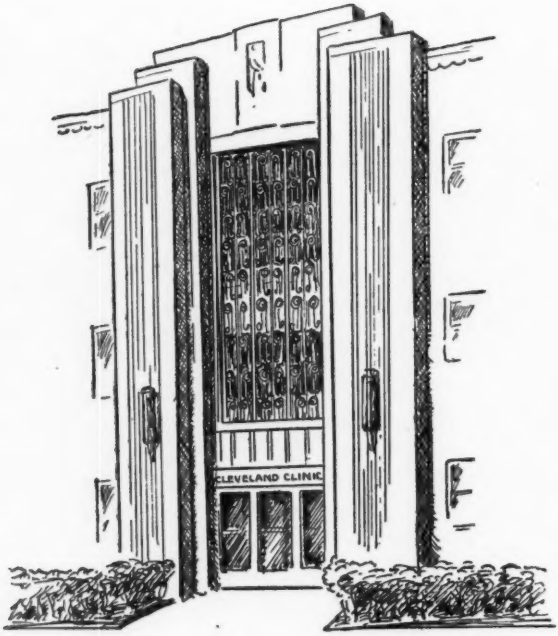
CLEVELAND CLINIC

MEDICAL PHYSICS III

OTTO GLASSER, Ph.D.

The desire to explore the interior of human body cavities is as old as medicine itself. Attempts to construct instruments to penetrate the depths of such cavities and to illuminate their interiors sufficiently to make them visible extend back well over 150 years. In their simplest form such instruments consisted of a cylindrical tube which was inserted into the cavity and which was equipped with mirrors to throw reflected light from outside sources upon the interior wall of the cavity.

Modern endoscopes are refinements of the earlier instruments. They consist of either rigid or flexible cylindrical tubes. Their length and mechanical construction depend mainly upon the cavity to be explored. Some of them are still simple hollow tubes, some contain ordinary magnifying lenses, and others are equipped with elaborate optical lens systems, permitting either unobstructed visual observation or photographic recording. The latter instruments usually consist of two parts, a tubular sheath and the optical system, which can be inserted into the sheath. The sheath can also receive instruments such as catheters and surgical appliances. The cavity walls may be illuminated by an electric bulb or by reflecting mirrors mounted in the ocular end of the endoscope, or by a tiny light bulb mounted on the tip of the endoscope introduced into the cavity. According to the construction of the endoscope, the cavity to be explored, and the desire of the physician to make visual observations or a photographic record, endoscopic instruments in use today may be classified in three groups:

1. Simple endoscopes with or without magnifying lenses

Anuscope	Otoscope
Bronchoscope	Proctosigmoidoscope
Esophagoscope	Stomatoscope
Laryngoscope	Televentroscope
Nasal and vaginal speculum	Ventriculoscope

2. Modified endoscopes with magnifying optical systems

Colposcope	Ophthalmoscope

3. Elaborate endoscopes with complete telescopic optical system

Antroscope	Nasopharyngoscope
Bronchoscope	Peritoneoscope
Cystoscope	Thoracoscope
Gastroscope	Urethroscope

Although some of these instruments, such as the bronchoscope, may be used either with or without an elaborate optical system and therefore may be listed in two classifications, the grouping as a whole is useful, particularly with regard to making a photographic record of the observation. Photographs may be taken with the endoscopes listed in group 3 by simply attaching a camera to the instrument. However, additional lens systems must be attached to the instruments listed in the other two groups before a camera can be used to record observations photographically.

Endoscopes are among the physician's and surgeon's most important diagnostic tools. Through the collaboration of physician and physicist the construction of the modern endoscope has been greatly advanced and has reached a peak in the flexible gastroscope combining some forty lenses in its optical system with a rather elaborate system of illumination.

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PROCTOSCOPY

T. E. JONES, M.D.

I wish to pay tribute to the many workers, too numerous to mention, who by clinical observation and development of new equipment have made proctoscopy a safe, relatively easy, and increasingly useful fact-finding procedure in the diagnosis and management of pathologic conditions of the rectum. Owing to refinements in procedure in this phase of endoscopy, diagnosis is more accurate and treatment more intelligent today than at any time in medical history. Indications for proctosigmoidoscopy may be summarized briefly as any rectal complaint. Unfortunately in 25 per cent of all cases treatments or operations for hemorrhoids have preceded the discovery of cancer of the rectum or sigmoid by less than six months. No specific procedure should be done on the rectum without proctosigmoidoscopy. I know of no contraindication except when digital examination shows it to be impossible, in which case plans may be made to make it possible.

Success in obtaining information by endoscopy depends in great measure upon making the examination as painless as possible. This is especially true of proctoscopy. We know from the patients themselves

that examination and operation are delayed because they are reputed to be very painful. This need not be so, and precautions must be taken to see that the examination, while not pleasant, is not painful. To fulfill this requirement it is essential that the patient be properly prepared and that the instruments be well lubricated and familiar to the hands of the examiner.

To avoid the necessity for repeating the examination, the bowel must be cleansed. If carcinoma or diverticulitis with possible obstruction is suspected, it probably is not wise to prescribe a powerful laxative. In most cases the patient need only be instructed to take an enema the night before and on the day of examination.

It is essential that both patient and examiner be in as comfortable a position as facilities permit. The patient may be placed in the left lateral, Sims', knee-chest, or knee-elbow position, or in the inverted position made possible by a tilt table. The lithotomy position is a hindrance. I believe the inverted position is superior to others. It is more comfortable for both patient and examiner.

Two very important procedures must precede proctoscopy, namely, inspection and digital palpation of the rectum. Simple inspection with the buttocks separated by the hands often reveals conditions which will cause pain if the proctoscope is introduced and in which it would be foolish to attempt proctoscopy. If the patient is hurt before information is obtained, he is likely not to come back for further investigation or operation. A painful fissure is easily observed, and when present some type of anesthesia must be given before instrumentation is attempted. If inspection is negative, digital examination is carried out. One should not have to be reminded that not only the tip but the entire gloved finger should be lubricated. Vaseline is sticky and is a poor substitute for a water soluble jelly. The finger should be inserted slowly and should be withdrawn in the same manner. By this procedure information is obtained regarding spasticity of the sphincter and direction of the anal canal as well as the presence of obstruction, such as stricture or tumor, which may make proctoscopy painful or impossible. The confidence of the patient may be attained by stating that the instrumentation will not be more painful than the digital examination.

A number of good proctoscopes and sigmoidoscopes are available today, some with illumination at the proximal end of the instrument and some at the distal, and the operator may choose one to his own liking. If digital palpation reveals a pathologic condition, the 4 inch proctoscope is usually inserted first. If not, the sigmoidoscope should be used at once to avoid the necessity for two insertions.

The well lubricated proctoscope is inserted in the rectum through the anus in the direction indicated by the digital examination, the plunger is removed, and the field is brought under direct observation. The great value of the inverted position is that, as soon as the plunger is removed, air passes into the rectum and the walls balloon out, making the insertion of the proctoscope under direct vision much easier for the examiner and less distressing for the patient. After the instrument has been inserted as high as possible, the mucosal surface is minutely examined as the instrument is slowly withdrawn. The use of suction apparatus or long cotton applicators is essential to keep the field clean. The proctoscope should be withdrawn as gently as it is inserted. Painless proctoscopy will inspire the patient's confidence if any operative procedure is to follow.

PERITONEOSCOPY

F. L. SHIVELY, JR., M.D.

Peritoneoscopy is being recognized as a valuable diagnostic procedure. In the few cases which are difficult to diagnose without exploratory laparotomy endoscopy of the peritoneal cavity and its contents may prove advantageous.

Although many uses for the peritoneoscope have been described, its practical use seems to be limited to the investigation of (1) ascites in the differential diagnosis of cirrhosis of the liver, generalized abdominal carcinomatosis, and tuberculous peritonitis and (2) liver disease, especially with hepatomegaly.

The value of the procedure is necessarily limited by what can be seen in the peritoneal cavity. The liver, falciform ligament, omentum, anterior surfaces of the small and large intestines, fundus of the gallbladder, pelvic viscera, parietal peritoneum, and occasionally the cecum and appendix can be seen.

Most authors agree that peritoneoscopy is contraindicated in (1) acute inflammation in the abdominal cavity, lest the infection spread; (2) distention, which increases the likelihood of perforating the bowel; and (3) the presence of known adhesions, although previous surgery does not absolutely contraindicate the procedure. In several cases adhesions from previous surgery in the upper right quadrant prevented observation of the part in question. Although it is not a contraindication, obesity may be troublesome since a large, fatty omentum may float over or adhere to the visceral or parietal peritoneum or both.

Preoperative preparation is the same as that for abdominal exploration. The abdominal wall is shaved, the bladder is emptied, and sedation adequate to allay apprehension and reduce susceptibility to pain is administered.

In the operating room the patient is placed on an adjustable operating table and is partially immobilized with shoulder braces and footboard. The abdomen is prepared with a suitable antiseptic and draped. Most patients cooperate very well under local anesthesia without supplemental intravenous or general anesthesia. The skin, subcutaneous tissue, and adjacent musculature in the midline just below the umbilicus are infiltrated with novocain. A 0.5 inch incision is made approximately 2 inches below the umbilicus, and by blunt dissection the subcutaneous tissue is separated down to the anterior sheath of the rectus muscle. At this point incision of the fascia facilitates introduction of trocars into the peritoneal cavity. A small trocar is inserted, the stilet is removed, and the abdominal cavity is distended with air. This trocar is then replaced with a large, lubricated trocar in its sheath. The stilet is removed, and after the lenses and the light have been tested, the telescope* is inserted. Since air may escape during the introduction of the second trocar and the peritoneoscope, the peritoneal cavity is redistended with air. The operating room is darkened, and the position of the patient is altered to expose the suspected lesion. At the end of the examination the telescope is withdrawn, the air is allowed to escape, the sheath of the trocar is removed, and the incision is closed with one or two clips.

When ascites is present, it is not necessary to produce pneumoperitoneum until the fluid has been removed. A blunt metal suction tube with multiple perforations is introduced through the sheath of the trocar. A specimen of fluid is obtained in a sterile bottle for examination for tumor cells, protein content, bacterial content, and so forth. The tubing is then attached to a sterilized gallon bottle so that the amount of ascitic fluid may be accurately measured. The rest of the procedure is carried out as previously described.

As experience with peritoneoscopy increases, the need for biopsy of the lesion decreases. In most cases the diagnosis is established by inspection alone.

This procedure as well as other forms of endoscopy is not without danger. The most frequently recorded complication is perforation of a loop of small intestine. For this reason it is well to be prepared for im-

*Ruddock Peritoneoscope

mediate surgical exploration. Hemorrhage, which is the second most frequent complication, usually occurs after biopsy and also necessitates exploration. When specimens for biopsy are taken, bleeding is controlled with electrocautery. Fortunately, these complications are not common and have not occurred in my experience.

Occasionally abscesses are inadvertently entered during the procedure with dire consequences. One death resulted from this complication. Preoperatively carcinoma of the liver was suspected. After the peritoneoscope was introduced, a mass was found in the subhepatic space. While an attempt to determine the nature of the mass was being made, the telescope lens suddenly became clouded indicating perforation of an abscess. Exploration was immediately carried out and an abscess drained. In spite of supportive measures the patient died. Although the same result might have followed exploratory laparotomy, peritoneoscopy must nevertheless be considered as the primary factor causing the patient's death.

Syncope and collapse have resulted on several occasions and have been controlled easily with routine measures for shock. Occasionally minor complications are seen, such as subcutaneous emphysema, mild wound infections, continued drainage of ascitic fluid, and transient shoulder pain. Air embolism must be considered, although no cases have been reported. Peritonitis has not been a complication in my experience.

SUMMARY

Peritoneoscopy has been established as a diagnostic procedure. The examination is made with ease and with little discomfort to the patient. In most cases the procedure permits accurate diagnosis without subjecting the patient to exploratory operation. The patient need not be hospitalized for longer than one day and usually is able to leave the hospital on the same day. On the other hand, the efficacy of peritoneoscopy is limited by what can be seen. If there is any question about the diagnosis, the patient's abdomen should be explored and the lesion investigated.

The procedure is especially useful in the diagnosis of ascites. The telescope is introduced after paracentesis, and in most instances the underlying cause of the ascites is determined. Usually biopsy is not necessary, but a specimen can be easily secured with little discomfort to the patient when doubt exists as to the nature of the lesion.

GASTROSCOPY

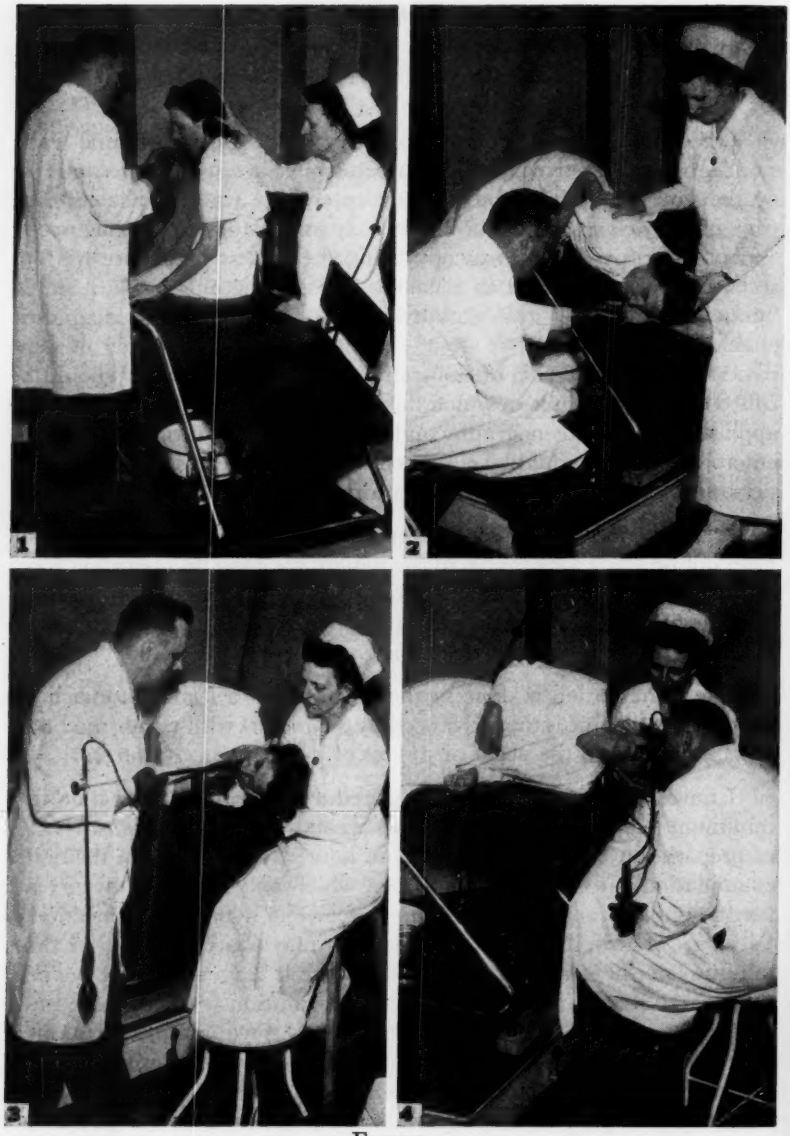
R. J. F. RENSHAW, M.D.

Three endoscopic procedures for study of the gastrointestinal tract, esophagoscopy, gastroscopy, and proctoscopy, are used unhesitatingly by the internist specializing in gastroenterology when indicated. The clinician is well aware of the limitations and values of esophagoscopy and proctoscopy, but gastroscopy being the newest procedure has but recently been established as a valuable diagnostic aid. Bockus[1] states, "unquestionably the flexible gastroscope is opening up new diagnostic channels. The method has already justified itself in the study of some patients with a suspicion of stomach disease . . . gastroscopy should be called upon in any case in which the diagnosis remains obscure after the application of roentgenography and other diagnostic aids. Every gastroenterologic clinic should be equipped with a flexible gastroscope and its personnel should include someone trained in its use."

It is agreed that gastroscopy is an office procedure. The examination need not be made formidable to the patient by using an operating room or an elaborate set-up. The examination is best performed in a gastroenterologic clinic, where results can be correlated by the gastroenterologist with those of other common gastroenterologic tests.

The examination is done in the morning on a fasting stomach. In general, the technic is that advanced by Schindler[2] with minor modifications according to the needs or desires of the examiner (figure).

I have found it advantageous to reduce the preparatory time to a minimum to prevent the patient from becoming unduly anxious. Whereas preparation used to take nearly an hour, I now complete the entire examination within thirty minutes, of which only fifteen or twenty are used in preparation. The patient first receives a hypodermic injection of 1/100 gr. of atropine and 1 gr. of sodium phenobarbital. Two or three minutes later he is given a gargle of a few cubic centimeters of 2 per cent pontocaine. Five cubic centimeters of the solution is then sprayed into the throat with a Schindler anesthetic tube.[2] Five minutes later this is repeated. Although the preparation time is short, the desired effect of atropine upon salivary secretion is obtained in at least 95 per cent of the cases. Sodium phenobarbital is not used for sedation but to counteract any idiosyncrasy to pontocaine. With this technic I have not had a serious pontocaine reaction in over six years.



FIGURE

1—Introduction of Ewald Tube. 2—Aspiration of gastric content without suction.
3—Introduction of Gastroscope. 4—Gastroscope at full depth of insertion.

Contraindications to the use of the flexible gastroscope are few.

1. Gastrocopic examination of the stomach should always be preceded by roentgenologic examination to exclude the principal contraindication, disease of the esophagus. Open tube esophagoscopy should be used in questionable cases. Although esophageal varices do not always contraindicate gastroscopy, this finding must be given special consideration before undertaking examination.

2. Diseases of the mediastinum, such as tumor or aneurysm, contraindicate passage of the gastroscope.

3. Acute febrile conditions, especially those designated "acute abdomen," and acute conditions of the stomach, such as acute or phlegmonous gastritis, contraindicate the examination.

4. Conditions which may make the examination undesirable, difficult, or impossible to complete include severe kyphosis or deformity of the dorsal spine, congestive heart failure, dyspnea or orthopnea from causes other than congestive heart failure, and lack of cooperation from the patient.

Age is not necessarily a contraindication. Successful examinations have been performed on patients in the eighth and ninth decades. On the other hand, I have not found it necessary to examine children under fifteen years of age and hence do not have a special small gastroscope.

The chief limitation of gastroscopy is the inability to visualize the entire stomach.[3] Blind spots include an area on the greater curvature at the tip of the instrument, a strip of the posterior wall underlying the instrument, the uppermost part of the lesser curvature, and a part of the fornix above the cardia. At times the lesser curvature of the antrum and the pylorus cannot be seen. These blind areas vary in incidence and size with every subject, and there is no way to predict from the roentgenogram or other observations whether an area will be seen through the gastroscope.

The chief indications for gastroscopy are (1) negative roentgenologic examination when gastric disease is suspected and (2) abnormal but indeterminate or inconclusive roentgenologic findings. Gastroscopy is also of value in the study of (3) gastric ulcer, (4) malignant lesions, and (5) obscure symptoms or uncommon diseases of the stomach.

The principal value of gastroscopy is in the diagnosis of gastritis. With rare exceptions gastroscopy is the only clinical means for establishing this diagnosis. Although the true significance of the mucosal

changes noted gastroscopically has not been definitely settled, chronic gastritis undoubtedly is a definite entity, which at times produces severe symptoms. A small percentage of cases of unexplained massive hemorrhage from the upper gastrointestinal tract have been shown to be chronic gastritis. Many publications have dealt with the incidence and symptomatology of gastritis, but the preliminary report of Montgomery and others[4] appears to be the beginning of one of the most comprehensive studies yet attempted. In a small series they found that 50 per cent of the patients without demonstrable evidence of peptic ulcer suffered from some degree of gastritis.

My experience at the Clinic indicates that gastroscopy is of major clinical value as the only or principal means of establishing the diagnosis in 25 per cent of all cases examined. The diagnosis in most of the cases comprising this 25 per cent was chronic gastritis. However, a significant number of gastric ulcers which had not been detected roentgenologically were found by gastroscopy. Also the diagnosis of a significant number of doubtful cases of benign and malignant ulcers and tumors was definitely established by gastroscopy.

In the study of gastric ulcer adequate roentgenologic examination usually reveals conclusive evidence of the benignancy or malignancy of the lesion and the progress or healing of the ulcer. However, in a fair number of questionable cases of gastric ulcer the gastroenterologist by means of gastroscopy is able to establish the true diagnosis or lend invaluable aid. Gastroscopy has a similar value in the study and diagnosis of gastric tumor. The operability of a malignant neoplasm often can be better determined by a combination of roentgenoscopy and gastroscopy than by the former alone.

The study of obscure symptoms is greatly aided by gastroscopy. As shown by Montgomery and others[4] a diagnosis of psychoneurosis is not justified without the use of gastroscopy in the differential diagnosis. The relation of obscure symptoms to gastrointestinal allergy and chronic dermatoses is being studied.

SUMMARY

Gastroscopy is an office procedure. Contraindications for examination are chiefly diseases of the esophagus or mediastinum. Limitations are few, the main one being the "blind areas," which vary in size. Gastroscopy is of value and is indicated (1) in further study of patients

with negative roentgenologic findings in whom gastric disease is suspected, (2) for classification of many cases with indeterminate, suspicious, or inconclusive roentgenologic findings, and (3) for elucidation of certain obscure conditions such as unexplained gross hemorrhage and gastrointestinal allergy.

Gastroscopy in combination with roentgenoscopy and study of gastric content removed by fractional method of gastric analysis has made the diagnosis of organic disease of the stomach comparatively simple. The diagnostic study of many patients cannot be considered adequate and complete without gastroscopy. When indicated, gastroscopy provides convincing evidence of its diagnostic value.

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CYSTOSCOPY

CHARLES C. HIGGINS, M.D.

In 1805 Bozzani of Frankfort devised an instrument that for the first time permitted visualization of the male urethra. This was the first of three contributions that established principles upon which all later cystoscopes were constructed. In 1883, three years after the invention of the incandescent light by Edison, Newman of Glasgow applied this new source of light to the cystoscope. Boisseau du Rocher, however, is credited with inventing the incandescent light cystoscope with the direct view and megaloscopic optical arrangement.

At the beginning of the twentieth century American workers directed their attention to improvement of the cystoscope. The Kelly indirect endoscope was perfected by Reinhold Wappler and Otis. In 1904 Lewis introduced the operating cystoscope, which permitted transurethral treatment of various pathologic lesions in the bladder. Accessory instruments included forceps, scissors, dilators, and extractors.

The classification of cystoscopes is according to the lens system. Nontelescopic instruments are based on the principle of direct vision through a simple tube, and magnification by lenses is not used. Tele-

scopic instruments are further classified as direct, that is, with the plane of vision perpendicular to the axis of the telescope, or indirect with the field deflected 90 degrees.

Cystoscopy is indicated in practically all chronic disturbances of the urinary tract when no contraindication exists. Accordingly intravesical investigation is indicated in persistent urinary frequency, dysuria, or nocturia. In pyuria cystoscopy may be necessary to determine if the causative lesion is in the urethra, bladder, or upper urinary tract. Painless hematuria demands immediate cystoscopy and pyelography to determine the origin and the cause of the bleeding. This type of hematuria is not a disease requiring medication but a symptom demanding complete urologic survey. Although a clue as to the source of bleeding may be elicited from the history and the nature of the hematuria, this may be misleading as will be evidenced by cystoscopy. The bleeding is often intermittent, and a long time may elapse between attacks. Such remissions may lull the physician into a false sense of security, so that a lesion such as a bladder tumor may be surgically incurable when it is finally revealed by cystoscopy. That the clinical significance of hematuria is minimized is evident from the interval usually reported between the onset of hematuria and an accurate diagnosis.

Persistent or intermittent pain in any quadrant may be associated with renal or ureteral pathology, and cystoscopy or intravenous urography is warranted if it cannot be satisfactorily explained. Frequently a diagnosis of chronic appendicitis is made when actually a stone lodged in the lower right ureter is responsible for the pain. It is well to recall that in obstructive lesions of the upper urinary tract gastrointestinal symptoms may predominate. Therefore when gastrointestinal study fails to reveal the cause for ill-defined gastrointestinal symptoms, the upper urinary tract should be studied even though the urine is normal. A noninfected hydronephrosis may be the source of the trouble. Pain in the suprapubic region may be of sufficient severity to warrant cystoscopy, since a calculus, Hunner ulcer, or other lesion may be present.

Case 1—A dentist, aged 51, entered the Clinic July 24, 1944 with the complaint of "trouble with the colon and frequency of urination." Burning and frequency had been present for several years, frequency occurring every two hours. A full bladder caused suprapubic pain. Symptoms seemed to be aggravated by episodes of colitis. Previous urinalyses were normal. The urinary symptoms were becoming more pronounced but were attributed to nervousness.

A roentgenogram was normal. An excretory urogram showed prompt function of both kidneys. The kidneys and ureters were normal without evidence of obstruction or retention. Total renal function was normal. The urine was normal and the culture sterile. Cystoscopy revealed a bladder capacity of 130 cc.; further distention produced supra-

pubic pain. On the anteroposterior wall of the bladder was an area measuring several millimeters which was bright red in contrast with the adjacent normal mucosa. The area was bleeding slightly from overdistention of the bladder. Adjacent blood vessels stood out prominently. Touching the ulcer reproduced the suprapubic pain. Superficial fulguration of the ulcer through the operating cystoscope relieved the symptoms.

Comment—Although the symptoms suggested Hunner ulcer of the bladder, the diagnosis could only be confirmed by cystoscopy. Since the urine is usually normal, the omission of cystoscopy increases the possibility of error in diagnosis.

The presence of a mass in either of the upper or the lower quadrants or in the suprapubic region warrants cystoscopy to determine whether the genitourinary tract is involved. If the mass is not in the kidney region, the possibility of an ectopic kidney must be considered. Obviously if clinical symptoms suggest a lesion in the gastrointestinal tract, this investigation should be made before cystoscopy.

Case 2—A woman, aged 48, entered the Clinic with the complaint of constipation, pain in the left side of the abdomen, and headaches. For ten years the patient took mineral oil with agar every other day for the chronic constipation. Diets failed to relieve the symptoms. The pain in the left abdomen was aggravated by gas and eating and was not relieved by bowel movements or enemas. Deep pressure over the left upper abdomen caused pain.

A scout film of the abdomen showed a large opaque shadow in the region of the right kidney. Intravenous urography showed prompt function of both kidneys and a large stone in the left kidney pelvis. The diagnosis was confirmed by cystoscopy and a retrograde pyelogram. There was some retention of dye in the left kidney and hydronephrosis. The bladder appeared normal, and the total function was normal. Urinalysis was normal. In a previous x-ray of the colon which was reported normal barium in the bowel evidently obscured the stone. The symptoms were completely relieved by surgical removal of the calculus.

Comment—In this case symptoms produced by the calculus were referred to the gastrointestinal tract. A normal urine and the absence of kidney symptoms favored the assumption that the urinary tract was not involved. In x-ray study of the colon the renal calculus was obscured by the barium. As a precaution a scout film of the abdomen should be taken before barium is introduced into the gastrointestinal tract.

In children cystoscopic examination of the bladder and pyelograms may be readily made with modern baby cystoscopes. The presence of congenital lesions such as urethral valves and ureteroceles, which would eventually destroy the kidney, may be diagnosed and successfully treated.

In acute inflammatory conditions of the bladder and kidney, cystoscopy should be delayed until the acute symptoms subside under medication and general treatment. Likewise small caliber stricture, acute infection of the prostate, and prostatic abscess may contraindicate cystoscopy. Cystoscopy may be performed only with considerable risk in the elderly debilitated patient with an enlarged prostate. Cystoscopy may be sufficient to activate an incipient uremia and cause the death of the

patient. In such patients blood chemistry studies may be secured; a high blood urea contraindicates immediate cystoscopy.

In most adults local anesthesia suffices for a complete cystoscopic study. In patients with pronounced bladder irritability pentothal anesthesia may be very effective. For children, however, gas-oxygen or ether anesthesia may be advisable. For local anesthesia I prefer diothane hydrochloride, 1 per cent; 2 ounces may be instilled into the bladder and urethra with a bulb syringe. Four per cent metycaine or 1:250 nupercaine may also be used. Whether or not general anesthesia is given, gentleness in handling the cystoscope is of prime importance.

Comfort for the patient on the cystoscopic table should receive first attention, and the cooperation of the assisting nurse is essential. It is well to adopt a specific routine for the inspection of the bladder; this permits more rapid and complete visualization and eliminates unnecessary manipulation of the cystoscope. After the cystoscope is gently introduced into the bladder, a specimen of urine is obtained for analysis. Approximately 150 cc. of fluid is then introduced into the bladder to permit adequate visualization. By gently rotating the cystoscope the bladder is completely inspected, after which catheters are passed up each ureter to the kidney pelvis. After catheterization of the ureters the instrument is gently withdrawn leaving the ureteral catheters in place. If the cystourethroscope is used, the urethra is inspected prior to catheterization of the ureters. Specimens of urine may now be secured from each kidney for analysis, after which phenolsulfonphthalein studies are made. This is followed by pyelograms, and as a general rule I prefer bilateral ones. The ureteral catheters are then gently removed. If pyelograms are made, it is well to have a bed available where the patient may rest for half an hour before going home. Gentleness in cystoscopy is rewarded by absence of reactions.

With modern instruments many lesions of the urinary tract can be successfully treated without recourse to open surgery. Benign tumors of the bladder (papillomata) may be adequately treated transurethrally with the resectoscope or operating cystoscope. Beer first used the insulated wire electrode for fulguration of papillomata of the bladder. One of the most useful electrodes employed today was designed by Bugbee and permits complete destruction of the tumor with the fulgurating electrode. I prefer to resect large tumors with the McCarthy resectoscope.

Case 3—An executive, aged 48, entered the Clinic with the complaint of hypertension. An examination for insurance a year before revealed that his blood pressure was

175 systolic and 104 diastolic. The systolic pressure rose to 195 with exercise. He was advised to lose weight and was given medication by his physician.

He was referred to the department of urology for investigation of the possibility of a Goldblatt kidney. Urinalysis showed 15 to 25 red cells by high power field and a trace of albumin. An x-ray showed that both kidneys were normal in size, shape, and position and that no calculi were present. Cystoscopic inspection of the bladder revealed one tumor the size of a cherry and several smaller ones above the left ureteral orifice. The ureters were not obstructed, and specimens of urine from the kidneys were normal. Bilateral pyelograms were normal. Biopsy report of a specimen secured transurethrally was "papilloma." The tumor was completely destroyed by transurethral fulguration. Cystoscopy revealed no evidence of recurrence two years later.

Comment—Although no clinical symptoms were indicative of a tumor of the bladder, 15 to 25 red blood cells per high power field were found in the urine specimen. The diagnosis could be established only by cystoscopy. Thus the lesion was detected early, and the necessity for open operation obviated.

A resectoscope may be used to resect small malignant tumors on the floor of the bladder. After this radon seeds may be accurately implanted in the base of the tumor by means of a special carrier. Large malignant tumors, however, require more radical treatment.

The operating cystoscope may be used to manipulate stones in the ureter to hasten their spontaneous expulsion without recourse to open surgery and to dilate or cut abnormally small ureteral orifices. Depending upon their size and shape foreign bodies in the bladder may be removed immediately by utilizing special grasping forceps introduced through the operating cystoscope.

Specimens from bladder tumors may be secured by use of the operating cystoscope and biopsy forceps. This provides material from which one can determine whether the tumor is benign or malignant. Thus information is provided on the basis of which adequate treatment may be instituted.

In certain selected cases of Hunner ulcer overdistention of the bladder and superficial fulguration of the ulcer may be performed to alleviate the patient's symptoms and progressively increase bladder capacity. This is not so often employed as conservative treatment by instillation of 1 per cent silver nitrate after overdistention of the bladder.

I do not believe cystoscopy is complete without urethroscopic survey with the urethroscope or cystourethroscope. I prefer the latter instrument because the inflow of water unfolds the urethra and permits excellent visualization. Likewise the relation between ureteral orifices, trigon, sphincter, and juxasphincteric area as well as the posterior urethra is noted and well visualized. The presence of cysts, hyper-

trophied verumontanum, polyps, or tumors may be detected and adequate treatment instituted.

When indicated ejaculatory ducts may be catheterized, thus making radiographic study of the seminal vesicles possible.

SUMMARY

Patients with symptoms referable to the urinary tract should have a complete urologic survey before irreparable damage is done or a malignant lesion becomes surgically incurable. An accurate diagnosis can usually be accomplished by cystoscopy, intravenous urography, and retrograde pyelography. With our present instruments transurethral surgery may be advocated and is attended by the most gratifying end results.

OPHTHALMOSCOPE

A. D. RUEDEMANN, M.D.

Of almost equal importance to the ophthalmologist are the ophthalmoscope, the retinoscope, and the slit-lamp biomicroscope. The anatomy of the eye lends itself to accurate study by direct observation with various types of illumination. The latter limits the magnification here as it does with all other magnifying apparatus.

The opthalmoscope is undoubtedly the most widely known of these scopes because of its value to general medicine. Méry in 1704 accidently held a cat's eye under water and saw the blood vessels and color of the retina. In 1851 von Helmholtz reported an instrument which he called the ophthalmoscope by means of which "all the alterations of the vitreous body and of the retina which, until now, have been found in cadavers, will also permit of recognition in the living eye—a possibility which appears to promise the most remarkable advances for the hitherto undeveloped pathology of this structure." This promise has been more than fulfilled. Now less than 100 years later the examination of the eyegrounds is an important adjunct in the diagnosis of general disease. The ophthalmoscope was a tremendous boost to the medical man's ability to diagnose vascular disease as well as early cerebral lesions.

The ophthalmoscope is a simple instrument with a perforated disk to look through and a light for illuminating the inside of the eye. Since all eyes are not emmetropic, the lens, which is attached in various ways, is necessary to neutralize errors of refraction of patient and observer.

Although early instruments were obviously not as streamlined as those of today, observations made with them were usually without error.

Many of the best descriptions of the fundus were made by the so-called direct method. A wall light placed behind the patient was used as a source of illumination. To direct the light to the eye a plane or concave mirror was fixed to a handle with a battery of lenses to aid in observation. This was held at a meter's distance. A light collecting lens of 12 diopters was held approximately 4 inches from the eye to bring the light to a focus on the retina of the eye. Candles, oil, gas, sunlight, and electricity all served as sources of light for the examination of the eye. The self-illuminated ophthalmoscope with battery or the cord-handled ophthalmoscope has replaced the old direct reflecting scope for direct observation. Although one could see as well through the early models as the modern ones, Friedenwald made certain refinements in recent instruments to increase accuracy of observation. Better illumination, higher magnification, and daylight and red-free light are among the improvements.

Ease of observation makes the study of the fundus a routine part of every physical examination. The examination is neither difficult nor time consuming. Dilation of the pupil is indicated; although much can be seen through an nondilated pupil, a great deal more can be seen with greater accuracy through the dilated pupil.

The binocular scope permits better study of the depths of the fundus but has limitations because of the size of the instrument and the slight difficulty in manipulation. It is particularly valuable in the study of early edema of the optic disk and other early lesions. The instrument is especially valuable for those specializing in ophthalmology.

The first camerascope to photograph the fundus of the eye was made by Nordenson. Photographs are now made in color and have tremendous educational value. The collection of Arthur J. Bedell now comprises over 100,000 excellent fundus photographs.

The retinoscope makes possible the accurate measurement of errors of refraction. It is the best and an almost totally accurate means of ascertaining whether or not a child has a refractive error. Because refractions may be done accurately without subjective examination, the retinoscope is valuable in the examination of the very young, the very old, the illiterate, and of other persons who are unable to respond. To the oculist the retinoscope is as important as the ophthalmoscope. It makes him independent of the patient in the examination for glasses and gives him an accuracy not obtained by any subjective examination.

As the means of illumination were improved and various types of lenses, prisms, and other means of directing and reflecting light became

known, the third important eye scope was devised. This was the slit lamp biomicroscope, which permits detailed examination of lesions that could not be seen before. Recent models combine higher powers of magnification with better illumination. By means of special illumination Zeitz perfected the photographing biomicroscope for photographing the capillaries of the conjunctiva. The ocular conjunctiva presents a perfect field for the clinician to study capillaries in the living state, to observe circulation, and to see under high power evidence of the activity of the vascular tree. The physiology and pathology of a large portion of the capillary bed may be observed.

Through the development of the ophthalmoscope and allied instruments examination of the eye has been facilited. The use of these instruments by the general practitioner may further extend his ability to diagnose earlier and more accurately certain general diseases.

BRONCHOSCOPY

HAROLD E. HARRIS, M.D.

Strictly speaking, bronchoscopy is limited to the visual examination of the bronchi and originally was used to remove foreign bodies from the air passages. In its broader connotation it has even greater usefulness in the diagnosis and treatment of diseases of the entire tracheobronchial tree.

Jackson has been largely responsible for developing the technic of bronchoscopy to its present high efficiency. Because bronchoscopy seemed a formidable procedure, the general practitioner was slow to realize that the bronchoscope provided a means for diagnosing obscure pulmonary disease. Recent advances in thoracic surgery have emphasized the importance of bronchoscopy in early diagnosis, and consequently greater responsibility has been placed upon the endoscopist. This paper urges wider application of bronchoscopy to diseases of the tracheobronchial tree, not only obscure ones, but also many of the more common conditions which may be secondary to undiagnosed and more important pathologic conditions.

Bronchoscopy is closely related to the development of direct laryngoscopy and esophagoscopy. In 1897 Killian removed a foreign body from the bronchus through an esophagoscope and demonstrated the feasibility of lower bronchoscopy. The first authentic use of the bronchoscope in the United States was in 1897 by Coolidge, who re-

moved a fragment of tracheal cannula from the right bronchus. In 1905 Chevalier Jackson perfected a distally lighted tube that eliminated blind bronchoscopy and made possible the use of narrower and safer tubes.

Bronchoscopy is indicated when signs and symptoms related to the trachea, bronchi, and lungs cannot be explained by the physical findings, x-ray examination, and laboratory studies. Bronchoscopy is particularly indicated in unexplained rhonchi, râles, and localized dulness; in paralysis of recurrent laryngeal or phrenic nerve; and when x-ray examination reveals bronchial obstruction, atelectasis, emphysema, infiltration, cavitation, and mediastinal root shadows. Symptoms calling for bronchoscopy are unexplained cough with or without expectoration, hemoptysis, wheezing, chest pain, and dyspnea.

In the presence of a **foreign body** in the air passages the symptoms and findings are relative to the size, shape, chemical composition, and length of time the body has been lodged in the respiratory tract. The symptoms may simulate those of chronic bronchitis, asthma, bronchiectasis, emphysema, or atelectasis.

The possibility of a foreign body in the tracheobronchial tree should be suspected in any case of acute or chronic pulmonary suppuration. The following case report of chronic pulmonary suppuration due to a foreign body opaque to x-ray but not visible on a roentgenogram of the chest illustrates the value of bronchoscopy in diagnosis and treatment.

Case 1—A white man, aged 49, came to the Clinic on December 14, 1942 complaining of chronic cough productive of foul mucopurulent sputum present for four months. There was no chest pain, shortness of breath, nor hemoptysis, but there had been a loss in weight of 14 pounds since the onset of the illness. The illness began with a severe chill followed by fever, which confined him to bed for fifteen days. After x-ray examination of the chest a diagnosis of pleurisy was made. The patient recalled choking while eating chicken soup two days preceding the chill.

The patient was pale and emaciated and appeared chronically ill. The temperature was 99.4 F. There was some limitation of costal excursion on the right with diminished breath sounds and dulness to percussion over the right lower chest.

X-ray examination of the chest revealed that the right diaphragm was slightly elevated and partly obscured. Increased density of the right hilar shadow and of bronchial shadows on the right lower lung field suggested an inflammatory lesion, probably bronchiectasis or lung abscess.

Examination of the blood revealed 4,100,000 red blood cells, 19,550 white blood cells, 71 per cent hemoglobin, and a blood sugar of 97 mg. per 100 cc. Blood sedimentation rate was 1.77 mm. per minute. Urinalysis was normal, and blood Wassermann and Kahn tests were negative.

Bronchoscopy disclosed the right main stem bronchus filled with foul yellow pus. After aspiration a foreign body partly covered with granulation tissue and completely

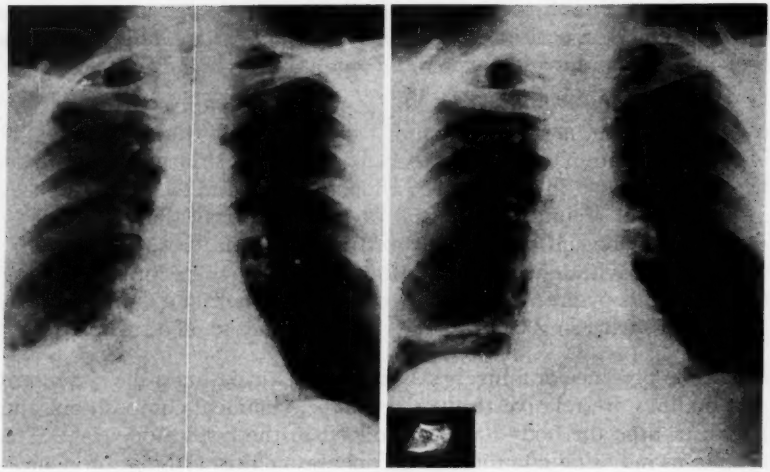

FIGURE 1

obstructing the lumen was encountered in the bronchus of the right lower lobe. The foreign body was anchored against the tip of the bronchoscope with grasping forceps and removed when the scope was withdrawn. The foreign body proved to be an irregular piece of dense cancellous bone. The entire bronchial tree below the area of obstruction was filled with pus. This foreign body was not visible on the roentgenogram of the chest but was found to be opaque to x-ray (fig. 1).

Postural drainage and a three weeks' course of sulfathiazole were prescribed. During the next two months the symptoms and the abnormal x-ray findings gradually disappeared.

In suspected **bronchogenic carcinoma** bronchoscopy with removal of tissue for biopsy affords a means of confirming the diagnosis and determining the operability of the case.

In **bronchiectasis** bronchoscopy is useful (1) in establishing the presence of obstructive lesions of the bronchi, such as foreign bodies, bronchial tumors, and bronchial stenosis and (2) in introducing lipiodol into the bronchial tree before bronchography to determine the presence and extent of the bronchiectatic process.

Lipiodol bronchography is an essential procedure in determining the advisability and extent of lung surgery. The method I have found most satisfactory in most children and some adults is the following:

After bronchoscopy and aspiration of pus a full length bronchoscopic suction tube is introduced into the bronchoscope. A 50 cc. syringe (Luer) containing the desired amount of lipiodol is introduced into the suction

tube, which is guided by the bronchoscope into either the right or the left bronchial tree. The lower lobes are outlined by elevating the head of the table, and the upper lobes are outlined by elevating the foot of the table. Rotating the patient carefully to the right or the left helps to fill the bronchus under consideration (fig. 2).

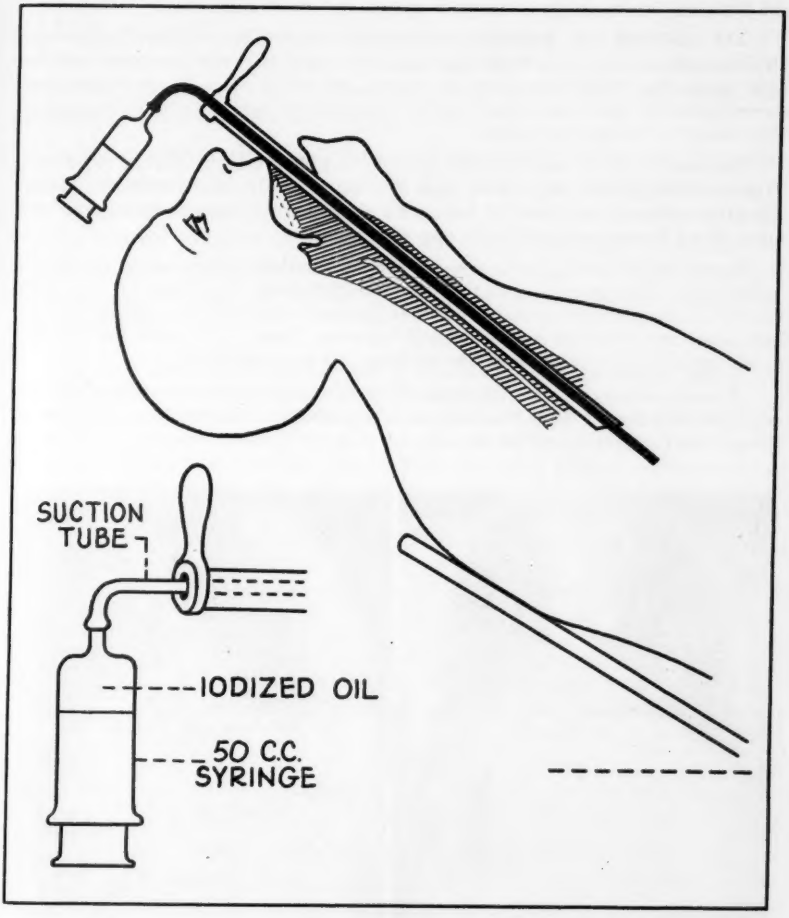

FIG. 2—Schematic diagram showing position of patient with bronchoscope in place. The suction tube is introduced through the bronchoscope and lipiodol instilled into the desired portion of the lung.

In the following case the bronchogram was made according to the described procedure.

Case 2—A boy, aged 8, came to the Clinic on July 25, 1944 complaining of chronic cough and purulent expectoration, which had been present for six and one-half years. A diagnosis of pneumonia was made several times. Hemoptysis was noted on several occasions after the last attack of pneumonia in February 1944. The mother reported that the child's appetite was poor and that he did not gain weight. She said that at birth there was "rattling" in the child's chest, more pronounced on the right side.

The child was pale, debilitated, and undernourished. He weighed 39.5 pounds. Oral temperature was 100 F. Chest examination revealed dulness to percussion over the right lower chest, high-pitched breath sounds, and coarse râles. X-ray of the chest showed extensive infiltration with thickened pleura at the base of the right lung, probably due to unresolved pneumonia.

Examination of the blood revealed 4,014,000 red blood cells, 9900 white blood cells, 75 per cent hemoglobin, and a blood sugar of 97 mg. per 100 cc. three hours after eating. The urine had a specific gravity of 1022, a Ph of 6.0, and was negative for albumin and sugar. Blood Wassermann and Kahn tests were negative.

Bronchoscopy was carried out under general anesthesia. The trachea was in the midline. The carina was sharp and vertical. The right main stem bronchus was partly filled with mucopurulent exudate, which was aspirated and found to be coming from the right lower lobe bronchus and its terminal branches. There was no bronchial obstruction to explain the bronchiectasis. The left bronchial tree was normal.

Twenty cubic centimeters of lipiodol was instilled into the right lower lobe bronchus and 10 cc. into the left lower lobe. The bronchogram revealed extensive saccular bronchiectasis of the right lower lobe (fig. 3).

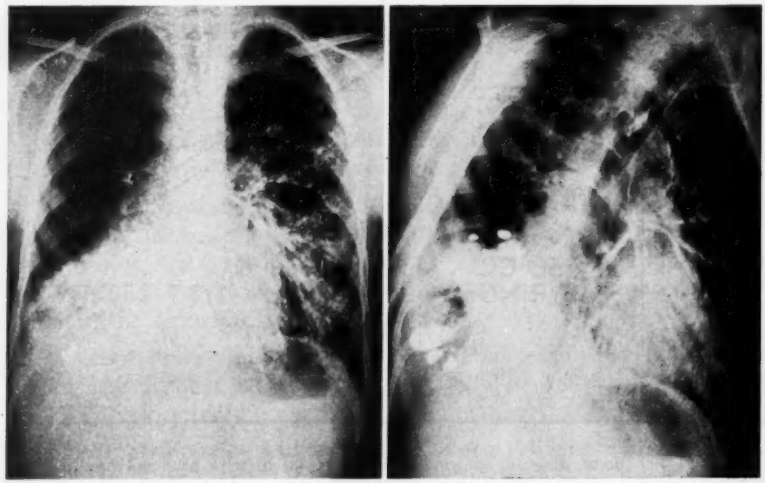

FIGURE 3

Most cases of **bronchial asthma** can be diagnosed without bronchoscopy. However, when allergy management is not effective in the treatment of asthma, bronchoscopy is indicated, since lesions producing tracheal obstruction may produce symptoms simulating asthma.

In allergic patients caution should be exercised in the use of anesthetic agents. I prefer 2 per cent cocaine to any synthetic agent. Never more than 4 cc. should be used. There is a tendency to use too much of the local anesthetic agent in these cases, because the patient's cough reflex is hyperactive. Also the anesthetic applied to the tracheobronchial tree is less effective, probably because of edema of the mucosa and the presence of thick mucoid secretions.

In **status asthmaticus** mucoid secretions which the patient is unable to expel by coughing may be aspirated by bronchoscopic suction under local anesthesia. This procedure followed by avertin anesthesia will usually control the attack. Because of the danger of depressing respiration in an exhausted patient whose tracheobronchial tree is partly filled with mucus, avertin should be given after bronchoscopic aspiration and not before.

Case 3—A farmer, aged 63, was seen in consultation with an allergist because of persistent asthma (status asthmaticus). He was admitted to the hospital on February 2, 1944 during a severe attack of wheezing and shortness of breath which did not respond to the usual treatment. During the next ten days he received frequent injections of adrenalin 5 minims, adrenalin in oil, paraldehyde and chloral hydrate, and intravenous injections of aminophylline with only slight improvement. The asthma continued with varying severity for two weeks. The patient showed evidence of severe exhaustion, and response to medication became less effective.

Bronchoscopy was advised and was carried out under local anesthesia. Two cubic centimeters of 2 per cent cocaine was instilled into the trachea in 0.5 cc. amounts. A large quantity of mucus was aspirated from the trachea and from the main stem and terminal bronchi. The wheezing continued, but there was some improvement in the shortness of breath. The exhaustion and excitability remained unchanged. He was then given 75 mg. of avertin by rectum and in approximately twenty to thirty minutes was sleeping. He slept for three hours and remained drowsy for twelve hours without wheezing or air hunger. The attack subsided; a mild recurrence one week later was controlled with adrenalin.

Obviously it would have been unwise to give this patient avertin and depress his respiration when the tracheobronchial tree was partly filled with mucus.

The average case of **pulmonary tuberculosis** does not require bronchoscopy for diagnosis. However, the tubercule bacillus frequently cannot be demonstrated in the sputum of a patient suspected of having tuberculosis. When all other diagnostic methods fail, microscopic examination of aspirated bronchial secretions frequently reveals the acid-fast bacillus. Bronchoscopy is also indicated (1) in the presence of sputum

which remains positive in spite of adequate therapy to determine the presence of tracheobronchial tuberculosis, (2) before surgery to identify a bronchial lesion or positive sputum in the opposite lung, and (3) to identify the type of bronchial lesion.

Pneumonia recurring in a particular area of the lung is probably due to a bronchial lesion. The following case illustrates the importance of bronchoscopy in recurrent pneumonia.

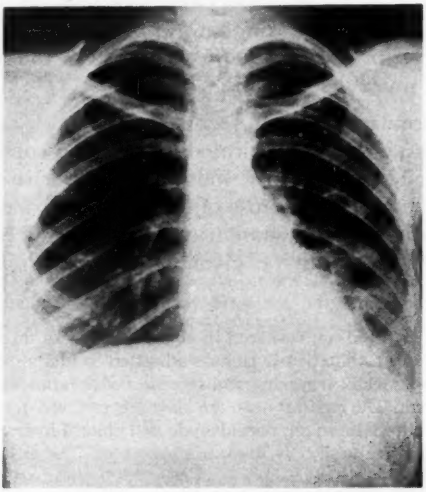

FIGURE 4

Case 4—A woman, aged 25, was admitted on October 11, 1944 with a history of eight attacks of pneumonia and pleurisy during the past eight years. She also complained of pain in the left lower chest and left shoulder which had developed two years before after an attack of pneumonia. Recovery from the pneumonia was slow. The chest pain was persistent and was aggravated by deep breathing and by lying down. A chronic cough was occasionally productive of mucopurulent sputum with streaks of bright red blood. The attacks of coughing were usually accompanied by chills and fever. Although tuberculosis was suspected, the sputum was never positive. There had been a gradual loss of weight from 130 to 95 pounds during the past two years.

Over the lower left chest posteriorly fine râles were heard with accompanying tenderness to pressure, dulness to percussion, and decreased breath sounds over the left base.

At x-ray examination of the chest, scattered through the lower left lobe were thin-walled cystlike cavities about 1.5 cm. in diameter surrounded by a homogenous density in the inferior portion of the lobe. The impression was of an inflammatory lesion with production of cysts in the left lower lobe, probably in the advanced stage. The diagnosis was bronchiectasis secondary to bronchial obstruction (fig. 4).

Examination of the blood revealed 4,440,000 red blood cells, 6150 white blood cells, hemoglobin 84 per cent, and blood sugar 102 mg. per 100 cc. The urine had a specific gravity of 1010, a Ph of 6.5, and was negative for albumin and sugar. No specific organism was found in the sputum.

Upon bronchoscopy the left lower lobe was obstructed by a smooth, rounded and lobulated, reddish tumor mass. The tumor, which was attached to the left lateral wall of the left lower lobe bronchus just below the upper lobe orifice, was removed through the bronchoscope. Bleeding from the tumor area was profuse. The bronchial tree below the tumor was filled with pus, and approximately 50 cc. of foul thin yellow pus was aspirated. The gross appearance of the tumor was that of a bronchial adenoma. This was confirmed by microscopic examination.

The bronchoscopic diagnosis was bronchial adenoma of the left lower lobe bronchus with secondary bronchiectasis in the advanced stage. Early diagnosis and removal of the tumor would have prevented the development of the extensive bronchiectasis.

When **hemoptysis** is not definitely associated with pulmonary tuberculosis, mitral stenosis, aortic aneurysm, or pulmonary embolism, bronchoscopy is indicated. Even with bronchoscopy the cause of bleeding in many cases cannot be determined. Frequently unexplained hemoptysis results from trauma to the trachial and bronchial mucosa from violent coughing. Abnormal fragility of blood vessels of the bronchial mucosa may also be a factor and may be determined by exerting gentle pressure on the bronchus with the tip of the bronchoscope. Other causes of hemoptysis are mucous polyps, malignant neoplasm, bronchial adenoma, bronchiectasis, tracheobronchial tuberculosis, or erosion of the bronchial wall in the presence of a broncholith.

The patient with a chronic cough is the victim of a vicious cycle. The more he coughs, the greater the trauma to the larynx and tracheobronchial tree. Thus the cough tends to persist. Bronchoscopy is usually indicated in any **unexplained cough,** even though the majority of these cases may be reflex in origin. Only by such an examination will unusual lesions be discovered.

Bronchoscopy is indicated as soon after operation as **atelectasis** or massive collapse of the lung is suspected. If the mucoid secretions are aspirated early, the postoperative course may be uneventful. The procedure should be carried out within the first twenty-four hours; after thirty-six hours reexpansion of the lung is more difficult, and pneumonia is more apt to ensue.

I believe that in many cases of postoperative atelectasis saliva has been aspirated during operation. During every general anesthetic the anesthetist should have equipment for oral suction, preferably a metal tonsil suction tip. If large quantities of mucus or saliva collect in the trachea at the completion of operation, bronchoscopic aspiration should be carried out before the patient returns to his room. In many instances

the patient does not have the inclination or strength to cough out the secretions.

The regional lymph glands may become infected, enlarged, and later calcified producing **broncholiths.** Consequent pressure on the trachea or bronchi causes varying degrees of stenosis. The most common cause of broncholiths is tuberculous lymphadenopathy. Occasionally ulceration may occur in the lumen of the trachea and bronchi. This produces obstruction with severe paroxysmal coughing or hemoptysis. The broncholiths may be expelled spontaneously, but frequently they can be identified and removed through a bronchoscope.

Bronchoscopy is also of value in the diagnosis of anomalies of the tracheobronchial tree, bronchial and tracheal stenosis, and rare pulmonary infections such as actinomycosis, blastomycosis, and leptothrix infections.

SUMMARY

Although originally designed for the removal of foreign bodies, the bronchoscope has become an invaluable aid in diagnosis and treatment of many bronchopulmonary conditions. The procedure should not be reserved for obscure pulmonary disease but should be utilized when indicated in the more common ones as well, since many of these are secondary to undiagnosed lesions in the tracheobronchial tree.

Specific indications for bronchoscopy are

1. Foreign body in the tracheobronchial tree
2. Suspected bronchogenic carcinoma
3. Bronchiectasis
4. Bronchial asthma
5. Unexplained hemoptysis
6. Pulmonary tuberculosis
7. Recurrent or unresolved pneumonia
8. Unexplained cough
9. Postoperative atelectasis
10. Broncholithiasis
11. Lung abscess
12. Tumor of the tracheobronchial tree, lung, or mediastinum
13. Stenosis of the trachea and bronchi
14. Anomalies of the tracheobronchial tree
15. Rare pulmonary infections such as syphilis and mycoses

In bronchiectasis endobronchial examination should always be done, and in children the bronchoscope affords an excellent means of introducing lipiodol into the desired portion of the lung after all available pus has been aspirated.

Advances made in thoracic surgery during recent years have placed new emphasis on the importance of endoscopy and greater responsibility on the medical profession for early diagnosis of the lesion.

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